Nanostructured thin-film tungsten trioxide photoanodes for photoelectrolytic production of hydrogen from sea water

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We report here some progress on the development of materials for photoelectrochemical water splitting with respect to solar hydrogen generation – a CO_2 neutral, clean energy technology (Figure 1).

Template-assisted sol-gel synthesis offers attractive possibilities of the controlled production of microporous and mesoporous oxide films, which are mandatory for photoelectrochemical applications. We prepare mesoporous tungsten oxide films based on the sol-gel method involving ultrasonic stirring step as the main improvement of the previously established procedure1. Investigation of solar-light-driven photo-electrolysis cell employing such a WO3 photoanode shows that the amount of the delivered steady-state photocurrent is increased by some 20%. This improvement is likely related to optimization in the morphology of the nanostructured films shown in Figure 2 consisting in a marked decrease in the particle size and, apparently, also in the film porosity.

Inspection of photocurrent-voltage curves, recorded under simulated AM 1.5 solar illumination, shows that stable photocurrents of the order of 3 mA/cm2 are attained in a 0.5 M solution of sodium chloride (Fig.1).

The latter solution, which is a composition close the lly occurring sea water, does not require any preliminary acidification as the formation of chlorine sets locally the solution pH to ca. 2. It should be noted that, although in 0.5 M NaCl ca. 20% of chlorine is formed at the WO_3 photoanode, oxygen remains the main photo-electrolysis product. Extended electrolysis experiments demonstrate perfect stability of the WO_3 photoanodes under conditions of mixed chlorine/oxygen evolution which allows anticipate its suitability for the sea-water photo-electrolysis2. The sea water is an abundant, non-toxic electrolyte suitable for massive hydrogen/ production via photo-electrolysis.

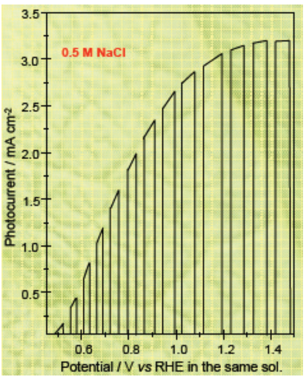

Figure.1: Schematized photoelectrochemical cell for solar water splitting.

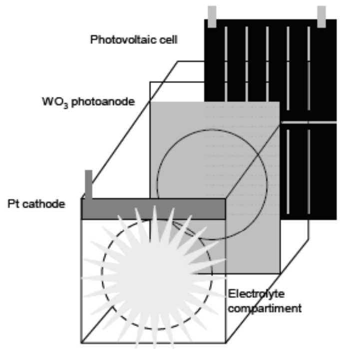

Figure.2: Photocurrent – voltage curve for sea-water splitting (recorded in a 0.5 M NaCl solution) at a semi-transparent WO3 photoanode obtained through the sol-gel route modified by ultrasonic stirring. Simulated solar AM 1.5 irradiatio.

References

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